DIPOLE MOMENT AND RELAXATION TIME OF CERTAIN TRI-SUBSTITUTED BENZENES

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ABSTRACT. Using the author's method, dipole moment and relaxation time are determined for six tri-substituted benzenes from measurements at 3.26 cms. Benzene is used as the solvent.

In a previous paper (Sobhandri, 1960), the author has described a method for evaluating relaxation times and dipole moments of certain polar molecules in dilute solution from measurements of the dielectric constant ϵ' and loss factor ϵ'' at a single frequency. This method is adopted in this paper for determining τ and μ of six tri-substituted benzenes for which no data are available in the literature. Benzene is used as the solvent. The experimental procedure was the same as the one described in an earlier paper (Narasimha Rao, 1956) from this laboratory. ϵ' and ϵ'' are calculated using the standing wave method of Roberts and von Hippel (1946).

Tables I to VI give the values of ϵ' and ϵ'' for different weight fractions along with the values of $\frac{\epsilon''}{\epsilon'-\epsilon_\infty}$. The mean value of $\frac{\epsilon''}{\epsilon'-\epsilon_\infty}$ is taken to calculate the relaxation time and the dipole moment. The final values of τ and μ are collected in Table VII.

All the molecules investigated may be taken as rigid and approximately spherical since they are formed by nuclear substitution in the benzene ring. The first four molecules (the toluenes) are of the same molecular weight, the main difference among themselves being in the location of the different groups. The other two are similar.

The dipole moment values obtained agree well with the r.f. values determined by Narasimha Rao (1956). Though the values of τ are almost of the same order for the four toluenes, a slight increase with increasing μ is evident. A similar feature may also be seen in the case of the other two nitrobenzenes. However, both μ and τ are considerably higher in the nitro compounds than in the toluenes.

TABLE I

6-Chloro 3-nitrotoluene

$\epsilon_1 = 2.270$

S.NO.	W	ϵ'	ϵ''	$\frac{\epsilon''}{\epsilon'-\epsilon_1}$
1	0 005578	2.296	0.01863	0.7164
2	0.006988	2 298	0 02141	0 7645
3	0.008614	2 300	0.02418	0 8060
4	0.010600	2.304	0 02828	0.8296
5	0.012590	2 314	0 03028	0.6880

Mean $\frac{\epsilon''}{\epsilon'-\epsilon_1} = 0.7609$

$\tau = 13.19 \times 10^{-12}$ Sec. $\mu = 3.09$ D

TABLE II

2-Chloro 4-nitrotoluene

$\epsilon_1 = 2.270$

S.NO.	W	ϵ'	ϵ''	$\frac{\epsilon''}{\epsilon'-\epsilon_1}$
1	0 004501	2 299	0 02443	0.8424
2	0.005178	2.301	0.02731	0.8810
3	0 007437	2.312	0 03598	0.8569
4	0.009552	2.322	0.04612	0.8869
5	0 010610	2 327	0.05110	0.8964

Mean $\frac{\epsilon''}{\epsilon'-\epsilon_1} = 0\ 8727$

$\tau = 15.14 \times 10^{-12}$ Sec. $\mu = 4.17$ D

TABLE III

6-Chloro 2-nitrotoluene

$\epsilon_1 = 2.270$

S.NO.	W	ϵ'	ϵ''	$\frac{\epsilon''}{\epsilon'-\epsilon_1}$
1	0.006063	2.294	0.01782	0 7425
2	0 007230	2 300	0.02065	0.6885
3	0 008710	2.304	0.02367	0 6961
4	0.10680	2.310	0.02855	0.7137
5	0.11650	2.316	0 03341	0.7261

Mean $= 0\ 7134$

$= 12.37 \times 10^{-12}$ Sec. $\mu = 3.11$ D

TABLE IV

4-Chloro 2-nitrotoluene

$\epsilon_1 = 2.270$

S NO.	W	ϵ'	ϵ''	$\frac{\epsilon''}{\epsilon' - \epsilon_1}$
1	0.005089	2 296	0.02011	0.7734
2	0 006531	2 304	0 02745	0 8074
3	0.007396	2 310	0 02928	0.7319
4	0 009208	2 317	0 03671	0 7811
5	0 011480	2 329	0.04640	0 7863

Mean $\frac{\epsilon''}{\epsilon' - \epsilon_1} = 0\ 7760$

$\tau = 13\ 46 \times 10^{-12}$ Sec. $\mu = 3\ 66$ D

TABLE V

2, 3-Dichloro nitrobenzene

$\epsilon_1 = 2\ 270$

S NO	W	ϵ'	ϵ''	$\frac{\epsilon''}{\epsilon' - \epsilon_1}$
1	0 00743	2.310	0 03698	0 9458
2	0 01040	2 319	0.04704	0 9601
3	0 01291	2 322	0.05070	0 9750
4	0 01614	0.327	0 05546	0 9729
5	0 01893	2 341	0 06963	0.9806

Mean $\frac{\epsilon''}{\epsilon' - \epsilon_1} = 0\ 9669$

$\tau = 16\ 77 \times 10^{-12}$ Sec $\mu = 3\ 82$ D

TABLE VI

2, 5-Dichloro nitrobenzene

$\epsilon_1 = 2.270$

S.NO.	W	ϵ'	ϵ''	$\frac{\epsilon''}{\epsilon' - \epsilon_1}$
1	0 008802	2.306	0 0320	0 8896
2	0 01030	2 311	0.0367	0 8960
3	0 01239	2 316	0 0441	0 9588
4	0 01601	2 325	0 0532	0.9674
5	0 1893	2.329	0.0549	0 9309

Mean $\frac{\epsilon''}{\epsilon' - \epsilon_1} = 0\ 9286$

$\tau = 16.11 \times 10^{-12}$ Sec. $\mu = 3.41$ D

TABLE VII

Temperature 28°C

Substance	$\tau \times 10^{12}$ sec.	μ	μ_r f.D
6-Chloro 2-nitrotoluene	12.37	3 11	2 93
6-Chloro 3-nitrotoluene	13 19	3 09	3 11
4-Chloro 2-nitrotoluene	13 46	3 66	3 63
2-Chloro 4-nitrotoluene	15 14	4.17	4 05
2, 5-Dichloro nitrobenzene	16.11	3 41	3 45
2, 3-Dichloro nitrobenzene	16 77	3 82	3.86

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